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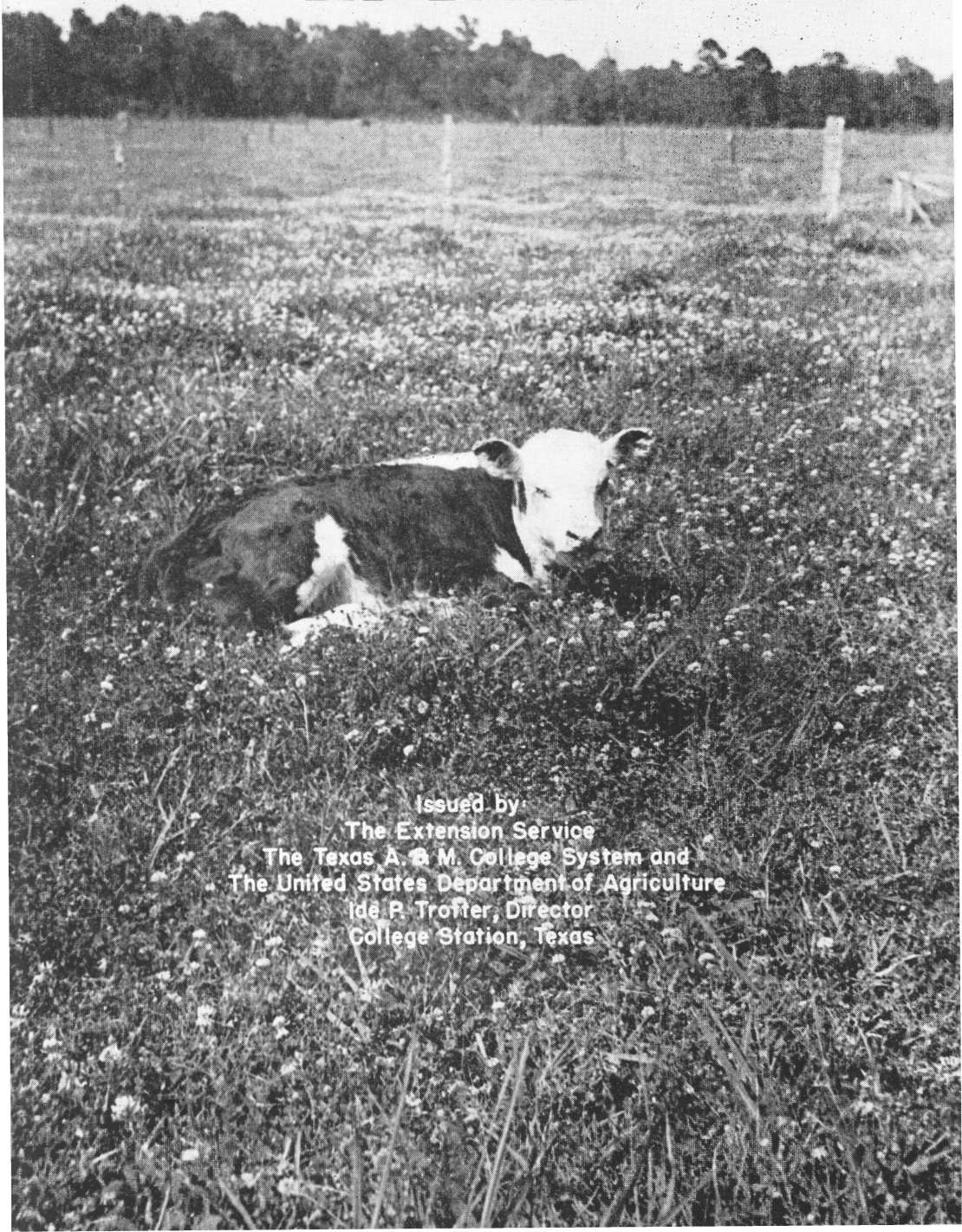
CLOVERS
for Texas Pastures



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Drawings: California bur-clover and spotted bur-clover are from **USDA FB 1741;** Hubam sweetclover and Madrid sweetclover are from **Britton and Brown's Illustrated Flora;** Crimson clover and white clover from **Legumes for Wildlife,** USDA Misc. Pub. 412; Alsike clover is from **USDA F1151.**

CLOVERS FOR TEXAS PASTURES

By

ROBERT R. LANCASTER, Extension Pasture Specialist

Texas A. & M. College System

Clover has always symbolized soil fertility, good luck and good farming. Clover's magic is its actual soil enrichment. Like all inoculated legumes, clover bears nodules of bacteria on its roots which have the mysterious power of obtaining nitrogen from the air. Maintenance of the human population depends upon clover and other legumes inoculated with bacteria restoring nitrogen to depleted soil. Clovers on fertile land may seem to grow well enough without inoculation, but their high protein content demands heavy withdrawal of soil nitrates and mineral nutrients. Thus, without inoculation they may be depleting the soil rather than building it.

EVERY GRASSLAND NEEDS A CLOVER AND EVERY CLOVER A GRASS

Raw, fibrous grass roots dying annually must have extra nitrogen to balance soil fertility. Without adequate nitrogen, the annual rotting of old grass roots and regrowth of new are slow, and the grass becomes sod bound. The germs of decay require a balanced diet to live and multiply. Sodland with a legume is the best known means to restore organic matter and thus to revitalize wornout land. Forest soils, in comparison with prairie soils, are lower in organic matter. Depleted cropland formerly in forest is very low. Clover in southern grassland adds to the total volume of production, especially in early spring when most needed, and crowds out early annual weeds and three-awn needle grass. Increased soil nitrogen from clover stimulates earlier growth, greater yield and more protein in other vegetation associated with it.

Bonemeal feeding is not needed for livestock on well balanced pastures of growing clover and grass or clover alone, even in vegetation regions normally deficient in phosphate. However, addition of phosphate to most soils is essential for high yield of clover. Clover is relatively high in phosphorus and other mineral nutrients as well as in vitamins and protein, but it is less so on poor land.

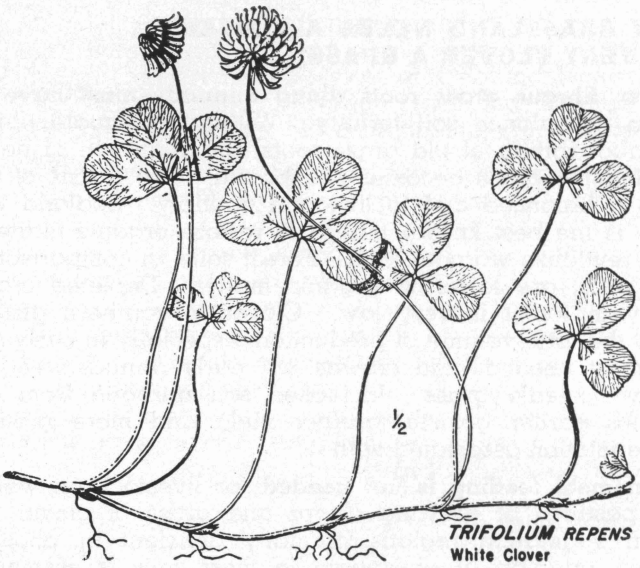
Four groups of leguminous pasture plants are called clovers in Texas. The true clovers are the genus Trifolium. In this

group are white clover, large hop clover, small hop clover, persian clover, and others of less importance at present. Another group or genus is Medicago including the various bur-clovers, black medic, and alfalfa. Sweetclovers are of the genus Melilotus. Lespedezas also are much like clover and common lespedeza formerly was known as Japan-clover. But little reference is made here to lespedezas.

TRUE CLOVER (TRIFOLIUM)

True clovers, such as white clover, hop clovers and persian clover, are best adapted generally to regions of more than 40 inches annual rainfall. Exceptions are the blacklands away from the coast and the tight redlands where black medic, not a true clover, seems better adapted.

White clover. Dutch white clover or Louisiana white clover (Trifolium repens), known by its frost-like leaf markings and small marble-sized globular white blossoms, is a perennial in northern states spreading by creeping stems, and rooting at the joints. In Texas, known erroneously as white "Dutch" clover, it usually dies after seeding in late spring, but may continue as a



White Clover

perennial where fertility and moisture and cool weather are favorable. Already it is the leading pasture clover on moist East Texas and Coastal low lands and rich bottoms. White clover is gaining on loamy hills where treated with lime and well fertilized

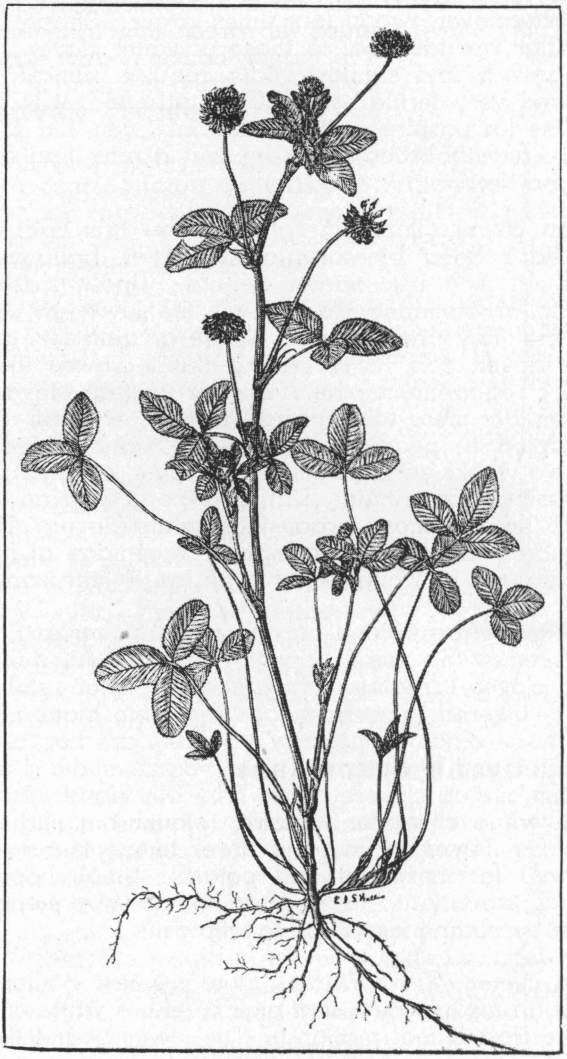
with superphosphate, with potash added wherever needed. Northern white clover seed is not adapted to Texas. Louisiana white clover is the strain adapted in the south.

Ladino white clover (T. repens Var. Ladino) is a giant variety of white clover, two to four times larger. Shape, color, and leaf markings are identical to those of white clover. Its large, vigorous growth and shallow roots require almost continual moisture and very fertile soil. Where adapted, it is commonly grown alone for pasture or in pasture mixtures. Its precedence has not been established in Texas, but it may find a place in irrigated pastures.

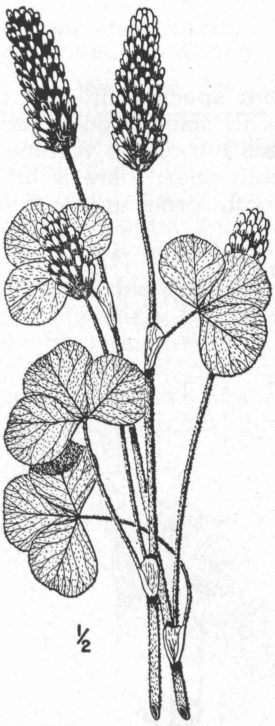
Persian clover (Trifolium resupinatum) has light purple or lavender flat-headed blossoms and inflated, balloon-like seed envelopes. It is a true winter annual. Under-grazing favors this tall, hollow-stemmed clover over the lower-growing white clover where they are together. Close grazing lets sunlight to the white clover, and its spreading habit crowds the persian. Soil fertility requirements are lower for persian clover than for white clover but more than for hop clovers. Persian also seems better adapted to poorly-drained depressions. Persian clover is about two weeks earlier than white clover, coming and going. The Mississippi Experiment Station reports persian clover as yielding 50 percent more forage than white clover. This greater yield more than offsets the higher percentage of phosphoric acid and protein in white clover reported by the same station.

Hop clovers are second only to white clover in East Texas. The two species are small hop clover (Trifolium dubium) and large hop clover (Trifolium procumbens). Their globular, yellow, many-flowered, blossom heads resemble black medic until the latter turns black at maturity. Seldom are hop clovers and black medic found together in Texas. Black medic is as strange to acid soils as hop clovers are to limy blackland. Hop clovers grow with white clover and persian clover but endure a little higher acidity, lower fertility and lower temperatures. Yet they respond well to phosphate and potash. Small hop clover is most widely abundant. Small hop clover is preferred, being earlier and permitting lespedeza to follow it.

Alsike clover (T. hybridum) blossoms are similar to white clover though mixed white and pink or either white or pink and without the frosted leaf marking. The stems bear flower heads along their entire length, the oldest below, the youngest at the top of the stem. It is naturally a perennial, yet in the south its habit is more that of a winter annual. Stems arise from a crown rather than from runners. It withstands more acidity and is adapted to stream bottoms or swales too wet for other clovers.



Alsike Clover



TRIFOLIUM INCARNATUM
Crimson Clover

Dixie crimson clover

Crimson clover (T. incarnatum) is not yet considered a permanent pasture plant, but it offers much as an erect winter annual legume alone or in small grain for temporary pasture in crop rotation, for green manuring, or for hay. The name crimson clover is derived from the bright crimson color of the spike-like seedheads. Dixie crimson clover is a composite of three high yielding, leafy, disease-resistant strains of reseeding crimson clover. Certified seed is available.

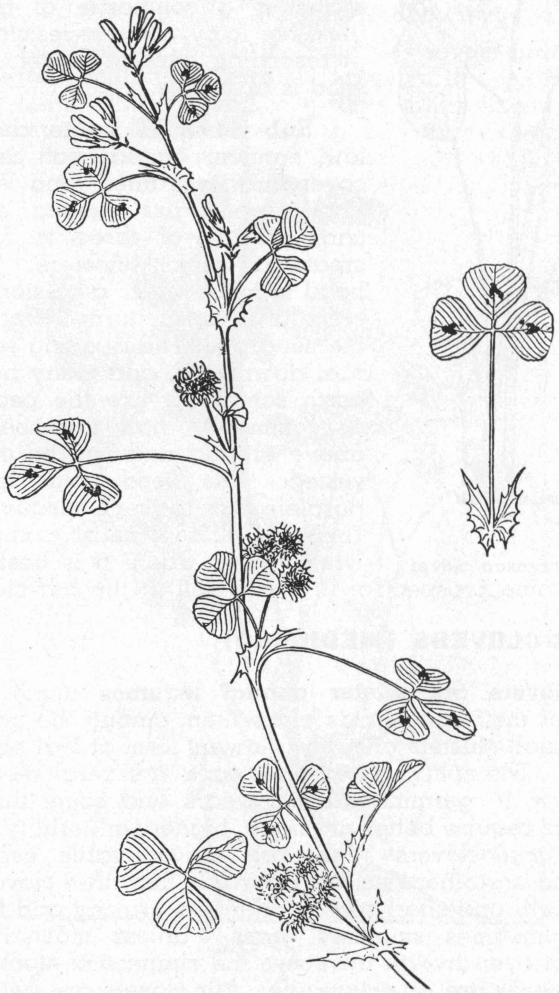
Sub clover (T. subterraneun) is a low, running annual, soft and wooly, covered with rather long soft hairs. Short seed-stalks among the taller carry clusters of three to four small creamy to pinkish flowers. The seedhead is made up of a cluster of forked hairs or bristles, turned back around the seed pod. The ripening seed-heads turn downward, and many bury in the earth somewhat like the peanut. But approximately half the seed remain above ground and can be easily harvested. The seed color is brilliant purple. Sub clover's disadvantage in Texas is that it must compete with white clover where it is best adapted. There is some prospect of it doing well in the bur-clover area.

THE BUR-CLOVERS (MEDICAGO)

Bur-clovers are winter annual legumes much like true clovers but their spiral pods place them among the many medicagos. Small clusters of yellow flowers form at leaf bases along the stems. The spiny, coiled pods contain several seeds. Some seeds delay in germinating two years and some three years. Bur-clovers require better drainage, higher soil fertility and more lime than true clovers. They are less palatable, especially to horses, and are otherwise less desirable than true clovers. Their quick growth and short season offer less grazing and their over-growth sometimes smothers grass. Unless mowed or close grazed, an over-growth increases the chances of stock bloating. Burs in fleeces are objectionable. Bur-clovers are better adapted to drier regions through Central Texas and westward in fertile low land toward a 25-inch rainfall limit. They succeed bet-

ter on soils high in lime. They are especially well adapted with bermudagrass and with johnsongrass on bottom land, and can be used in supplementary pastures.

Among the medicagos are many other species differing in form, size, and spines, including some with smooth pods such as button-clover, snail-clover, and spineless bur-clover varieties. Since spiny varieties soon mix with smooth ones, there is little practical value in trying to maintain smooth forms unless their

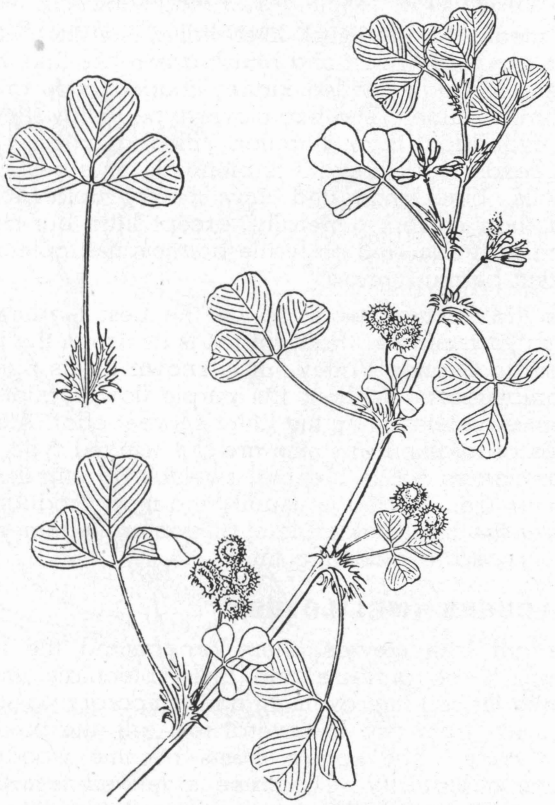


Spotted burclover, showing the butterfly stipules at the base of leaf stem.

yield proves to be greater. Five medicagos are common in Texas pastures: California bur-clover, spotted bur-clover, little bur-clover, black medic and alfalfa.

Spotted or Southern bur-clover (M. arabica) is readily known by the purple spot in the middle of each leaflet. The burs are larger and spines longer than on California bur-clover but smaller than on giant bur-clover varieties. Stipules at leaf-stem bases are like tiny butterfly wings edged with short, pointed lobes. Spotted bur-clover is more susceptible to leaf-spot disease but is more cold resistant than California bur-clover.

Little bur-clover (M. minima) is much like black medic before blooming, but its small yellow flower-clusters are quite unlike black medic's little balls of yellow flowers. It has very small and soft spiny burs and its velvet-like foliage is bluish-green. Little bur-clover has spread naturally throughout Central and North Texas blacklands, westward over the Grand Prairie and



California burclover showing stipules at leaf base deeply lobed and thread-like teeth between.

south to San Marcos, into the Edwards Plateau beyond Bandera and Kerrville, and gradually into low hard lands in the Rolling Plains. It is typically a winter-hardy annual legume ripening in late spring. This bur-clover, although not well known, may deserve attention as a green manure cover crop and for bermudagrass pastures as far west and north as the Rolling Plains. Little bur-clover has been found in Wheeler county. It is persistent and tenacious, but slow growth and small size restrict its suppression of grass. Commercial seed is not available.

California bur-clover (M. hispida) can be identified by the stipules at its leafstem bases. The stipule wings are deeply notched and the narrow teeth between extend into slender points. Usually it is recognized by not having leaf spots and by its shorter-spined burs, intermediate in size between the two previously described, and its leaf tips are finely toothed. California bur-clover is well established on the better soils of all types in Central Texas, excepting coarse sand.

Black medic (M. lupulina), like alfalfa, is without spiny burs. The leaves are velvety-soft and bluish green like little bur-clover. Top clusters of single-seeded kidney-shaped pods are blackish when mature in June. The hop-clover-type yellow flower-heads are more cylindrical than globular. Black medic is usually an annual in Texas, but, rarely, it is biennial. It is best adapted to alluvial soils, blacklands and limy, heavy uplands, enduring more cold than clovers generally, except little bur-clover It is valuable in pastures, and on fertile bottoms it supplements johnsongrass and bermudagrass.

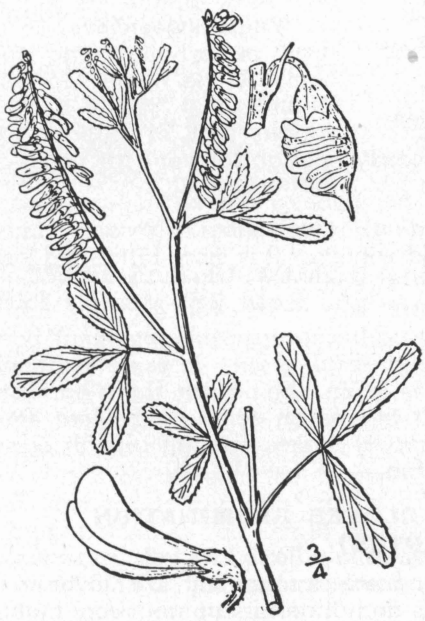
Alfalfa (M. sativa) seems to be the best legume for West Texas irrigated pastures. Root-rot limits its use in the blacklands and Lower Rio Grande Valley. It is known by its purple flower and perennial roots. Without the purple flower, alfalfa may be known from sweetclover by the latter's sweet odor. Also, stipules at the base of alfalfa leaf-stems are the winged type characteristic of bur-clovers, while biennial sweetclover stipules are slender and awn-like. Alfalfa is usually the most productive and in many places the most palatable of all pasture legumes. It retains its succulence up to blooming time.

SWEETCLOVERS (MELILOTUS)

While not true clovers, there are among the melilots or sweetclovers, three annuals and three biennials important to Texas chiefly for soil improvement and temporary pastures. They grow naturally from two to several feet tall, the biennials with very deep roots. The coarse stems become woody and the foliage bitter at maturity. The name is derived from the clover's sweet odor. The small blooms are in spikes, white or yellow according to species.

Sweetclovers resemble alfalfa when not in bloom, but are known by the sweet odor and the two awn-like stipules at the base of leaf stems. Alfalfa stipules are wing-shaped, more like the bur-clover.

Biennial Sweetclovers survive but one winter after planting, seldom producing seed the first year. Sown in the spring, they commonly grow two seasons before maturing seed. They may mature in one season from early fall planting and remain later in the season than annuals. Sweetclovers grow on almost all limy soils of good fertility except loose sand. They have potential values in maintaining and supplementing tall grasses such as rhodesgrass, johnsongrass, bluepanic, lovegrasses, native prairies and plains, and in tame pastures and meadows westward toward 25 inches rainfall where other legumes are less adapted. Also, they are grown as temporary pastures and as hay. In regions of from 25 to 30 inches rainfall in Texas, the irregular fall rainfall averages from 6 to 8 inches. For spring it averages from 6 to 10 inches, thus favoring winter clovers.



Madrid sweet with lateral folds on the seed pod.

Madrid variety of biennial yellow sweetclover (Melilotus officinalis) is most popular in northern and western Texas where biennials are grown. Its superiority is due to greater vigor, leafiness, seed production, finer stems, and its better withstanding of grazing, drouth and frost. Madrid sweetclover will not cross naturally with white sweetclover (Melilotus alba) strains such as Hubam.

Biennial sweetclovers are not so well adapted in southern areas of Texas as the winter annuals. This is due to the long, hot, dry summers and to cotton root rot. The greatest productivity is in the second year.

Evergreen variety of biennial white sweetclover compares well with Madrid in yield and quality though not so fine. It remains green later.

Hubam sweet clover with pineapple-like seed pod.

Hubam, (M. alba annua), is an annual form of white sweetclover. It is known from the biennial by its finer roots and from sourclover, the yellow blossomed annual (M. indica) by the white flower. Hubam sweetclover is a fall-planted winter annual in the southern half of the state. In North Texas it is sown in the early spring. Its maturity, too late to be followed by summer catch crops, is a drawback. Hubam fits well into johnsongrass and rhodesgrass but it retards the grass growth more than the yellow annual.

Yuma sweetclover is a strain of early-maturing Hubam. At the Winter Garden Station it yields nearly double that of Hubam by March 1. Yuma is not cold-hardy enough for very far north of the Winter Garden.

Sourclover (Melilotus indica), the yellow blossom winter annual, is best adapted to mild winters. It is more bitter and less desired for grazing than other sweetclovers but once used to it, stock graze it well. Sourclover volunteers well from its many hard seed. Its great merit is early maturity in permanent pastures or temporary pastures with small grain. In some locations seed can be harvested with the grain. Being upright, it harvests easier than vine legumes. It thrives on some of the less limy soils. As a green-manure crop, it makes enough growth early enough to turn under for cotton.

COOL WEATHER FAVORS CLOVER GERMINATION

Clovers generally are sown in middle to late fall. Lespedezas usually are sown in early spring unless sown with fall clover mixtures. Ordinarily clover seeds do not germinate until cool nights alternate with warm days. Seeded too early in the fall, young clover must compete with late growing mature grass. At this season, temperatures are high and drying is rapid. This is fatal, especially to artificial inoculation. Intermittent showers and sunshine and warm days are unfavorable to germinating seed and young seedlings. Cooler weather favors clover germination. In

the late fall less soil moisture is used by old grass as it matures. By shading, this old grass reduces evaporation and cools the soil.

LIGHT GROUND COVER FAVORS CLOVER STAND

Clovers generally make better stands in short, thin turf or in crop residue, litter or trash than on bare ground, excepting especially well-prepared seed beds. A straw mulch is valuable for dry weather plantings. Sweetclovers and bur-clovers do well also as winter cover-crops on firm but not crusted soil of bare fields.

Carpet grass may become so thick and rank it crowds out clover and lespedeza. Some other pasture grasses being naturally thinner on the ground are better for clovers. These include the bunch-type species such as dallisgrass, rescuegrass, ryegrass, the various western grasses and a few new ones. The running grasses—bermuda, buffalo, angleton, rhodes and johnson all offer room for clovers.

Winter clovers and summer lespedezas together in pastures are competitive in East Texas and on clay soil of the Gulf Coast Prairie under growing conditions favorable to both. Rank-growing spring clover may smother germinating lespedeza. Bermudagrass and lespedeza are adapted to drouthy hills in East Texas. Dallisgrass, bermudagrass and white clover or hop clover favor the moister lowlands. Heavy grazing or close mowing in time for lespedeza to start may be helpful. Lespedezas should be planted separately wherever clover is too abundant. In any case, dense grass and weeds must be mowed and disk-harrowed to favor clover germination and young seedlings.

CLOVERS FAIL ON COARSE SANDS, WET LANDS AND ACID LANDS

The constant disappointment about clovers is their tendency to fail on deep coarse sand, poor land, wet land, acid land, or loose, dry soil of any kind. Clovers seem especially averse to any combination of these conditions. On practically all other types of soils having at least 25 inches average annual rainfall, some one or more of the clovers are adapted. Generally they will respond to superphosphate. Clovers usually respond well also to potash in addition to phosphate on wornout cropland and depleted pasture land of East Texas, on sandy soils of the Coastal Prairie*, and on similar sandy soils elsewhere.

CLOVERS CAN'T STAND WET FEET

Land remaining soggy-wet in winter is lifeless, cold and without sufficient soil-air. For satisfactory crop growth all such wet land must be drained. This may include open flatwoods, flat coastal prairies, some stream-bottom land, and even sandy

*Alluvial river soils are not included as part of the true Gulf Coastal Prairie soil region.

upland of tight subsoil within heavy winter-rainfall regions. Surface run-off water is carried away generally by natural slopes and draws, by road-side ditches, and, in much flat country, also by special drain ditches with laterals. In some places additional drainage is needed to aerate and warm the soil for earlier and better winter growth of clovers.

PASTURE DRAINAGE

Excess water from higher land may be conducted away by diversion ditches. Drainage of pasture land need not be started without adequate outlet ditches that will carry away at least 3 inches of water in 24 hours from 320 acres.

Locate drainage ditches in middle of broad, low, natural drainage ways or shallow swales. Double, parallel ditches, with low ridge between, is made by spoil dirt from both ditches being graded to the middle. This may be used as a trail or roadway.

A V-type ditch may be used between low places where a considerable cut must be made.

Corrugated lands, 50 feet wide, are effective on poorly drained land. The open dead furrows or graded middles open into drainage outlets. Where these corrugated lands are graded, the dirt must be carried full half-way between middles. Small knolls and buffalo wallow depressions can be smoothed by the grading. Because of carrying this dirt, it is less expensive to make narrow lands than too broad.

FERTILIZERS ARE NEEDED ON POOR SOIL

Clovers require large quantities of phosphate and potash. This is indicated by the following proteins produced and the minerals taken from the soil:

	Yield	Protein Produced	Minerals Removed	
			Phosphoric acid	Potash
Alfalfa	2½ tons	735 lbs.	24 lbs.	121 lbs.
Sweetclover	2½ tons	700 lbs.	21 lbs.	107 lbs.

These figures remind us that highly nutritious forage causes high removal of plant food.

Superphosphate has proved effective for legumes on most soils in the state where average annual rainfall is above 25 inches and on many sandy soils of areas between 20 and 25. The Gulf Coast Prairie and East Texas are naturally deficient in phosphorus. Potash is generally needed in sandy soils of those regions in addition to phosphate, especially on wornout fields. Also, it is in those regions where soils deficient in calcium may be found.

Dark, heavy prairies, valleys and bottoms generally respond well to phosphate but are less likely to need potash. Fertilizers

Bottomland pasture in East Texas
(Courtesy Tex. Agr. Exp. Station)

for the first clover planting may include nitrogen with phosphate such as 300 to 500 pounds 6-12-0 or 150 to 250 pounds of 16-20-0. Maintenance may call for 300 pounds or more of 20 percent superphosphate, say every three years. Old-field land may need 5-10-5 to start legumes.

Sandy land of the Gulf Coast and East Texas Uplands generally responds to both phosphate and potash. First plantings of legumes may also need some nitrogen. These situations indicate such fertilizer treatment as 300 pounds or more to the acre of 3-12-12 for these areas and for the West Cross Timbers 4-12-8. Maintenance may be 300 pounds or more of 0-12-12 after three years.

The common fertilizer rate is 25 pounds P_2O_5 per acre per year. That is, 125 pounds of 20 percent superphosphate per acre for one year; 250 pounds for two years; 375 pounds for three years, etc., in advance. The relative rate of potash should generally be one-fifth as much as superphosphate or more rather than less than an 0-2-1 ratio. A more equal ratio of potash to superphosphate may be appropriate for successive applications because of potash leaching. Less is likely to be needed in the West Cross Timbers.

Highly acid, heavy soil, (pH 6.0 or below for those who test) may need a ton of ground limestone per acre. Less may be needed on lighter soils, more on clay, but none for deep sand low in organic matter. Blackland generally needs no potash or lime. If lime is used, apply it first, preferably in summer or early fall. Later, apply the phosphate and potash.

GET A STAND OF GRASS BEFORE SEEDING CLOVERS

In starting new pastures of grass and clovers, first get a good stand of the base grasses. In any area they are the best-adapted perennial grasses. They are the foundation upon which a pasture is built. Bermudagrass is the most dependable base grass for Central and East Texas down to the Gulf Coast, and it is associated with dallisgrass on bottom land, swales and the better soils. Carpetgrass grows best on very moist soil not fertile enough for bermudagrass, while rhodesgrass is better in South Texas. Buffalograss is a base grass for limy, tight fertile soils. Starting new grasses on poor soil in humid regions requires about 300 to 500 pounds 5-10-5 fertilizer or 5 tons manure per acre with 200 pounds 0-14-7. Afterward for clover, apply 300 pounds of 20 percent superphosphate and about one-fifth as much or more muriate of potash, if needed. Also on poor soils, legumes with fertilizers can be used to build up the fertility and soil tilth before establishing base grasses, and with grain provide temporary pasturage.

PREPARATION FOR NEW PASTURES

Apply superphosphate before plowing to make deep-rooted pastures. Deep roots in fertile soil cause white clover to remain alive on the Gulf Coast Prairies through the summer. White clover is naturally a perennial. Where superphosphate is applied on top of clay soil, clover and grass roots remain shallow. Both white clover and bermudagrass spread by surface runners with shallow roots. They are able to take phosphate at the surface when the soil is moist, but not when it is dry. It is when pastures are dry that phosphoric acid is deficient, and is most needed both for the plant and for the animal.

Shallow rooted white clover dies in summer. Deep roots maintain it as a perennial. Perennial white clover provides more late fall grazing. Very little grazing of animals is gained until spring.

Fall seeding of mixed clovers and grasses has proved satisfactory near the coast. Better stands come from seeding on clean, well-prepared, firm seedbed. In trash or on sod, many seed do not get to the ground.

Irrigated pastures are another exception to seeding grasses and clovers separately. Base seeding mixtures of bromegrass and alfalfa for western irrigated pastures, may include also some bunch grasses as perennial ryegrass, fescuegrass, orchardgrass, and in the South, dallisgrass, fescuegrass and KR bluestem. But the alfalfa rate should be as low as one to two pounds per acre to prevent its bloating cows and sheep and over-crowding the young grass.

Clovers should be seeded after the grass becomes well enough established to withstand competition the next fall or a year later. Generally clovers in pastures are limited to regions of 25 inches or more average annual rainfall, in lower rainfall areas where land is irrigated, above terraces, or to other locations where there are accumulations of moisture. Adaptability should be known or investigated before planting clovers extensively. It is better to test them in small patches. Seed may be drilled or broadcast or mixed with manured soil and spot dropped. The land should be lightly disked or harrowed and the heavy soils rolled with a cultipacker. Cultipacking cannot be over-emphasized.

The soil should be moist, not dry when disked. It is better to disk the soil a little on the wet side rather than wait too long. Sod land, particularly bermudagrass, should be well disked, if necessary weighted with 200-400 pounds on heavy soil, but not worked enough to destroy the sod or trash mulch. Breaking bermudagrass and johnsongrass, leaving the furrow-slice edge-up, may be desired. Disking grass sod lightly in early spring is more apt to benefit the grass than injure it. Bermudagrass especially does better. Too much old vegetation might necessitate some of it being removed for the disk to cut through. Superphosphate must be worked into the soil for contact with moisture, and inoculated seed must be lightly covered.

Red River bottom land pasture with white, persian, hop and black medic clovers

Cultipacking both before and after sowing or after natural seeding is most beneficial after disking. Next to the mower, the cultipacker is reputed to be the most valuable pasture implement, (grubbing hoe, for shrubs, third). Loose soil is pressed together

closing air pockets and pressing upper soil down against moist soil below. There is no substitute for a firm, fertile, moist seed bed. The cultipacker rolls, pulverizes, packs, evens, cultivates, and mulches the soil in one operation. Even old pastures may be greatly benefited by cultipacking, especially uplands cultipacked on the contour. Of course, many locations are too rocky, stumpy or otherwise unsuited to the use of such implements. The pasture rolling-cutter is excellent for most difficult situations before and after fertilizing and seeding. It also serves as a mower and is highly satisfactory in controlling brush.

INOCULATE ALL CLOVERS THOROUGHLY

Three times or more the commercially recommended rate of inoculation for clover seed assures much better stands the first year.

To inoculate clover seed:

(1) Spergon treatment before inoculation assures better germination.
(2) Mix seed with thin syrup until all are sticky.
(3) Give each kind of clover its particular inoculant separately and mix well.
(4) Add cottonseed meal until seeds separate.
(5) Keep inoculated seed shaded from sunlight.
(6) Plant as soon as possible.
(7) Cover inoculated seed as soon as it is sown.

Clover seeds requiring different inoculants must be treated separately to concentrate the right bacteria on its particular kind. The soil should be moist and well packed before seeding. Seed should be sown soon after inoculation to prevent drying or molds forming. Spergon treatment of inoculated clover seed is reputed to reduce damping off of seedlings and aids in the free flowing of seed in the drill. Plantings on dry soil with prolonged dry periods may fail because of poor inoculation. Seedings broadcast in a rain or seeding followed immediately by rolling afford bacteria protection. Also a good practice is to seed late in the afternoon and disk the seed in early the following morning.

Re-inoculate if dry weather follows the seeding. Clovers already planted may be re-inoculated as the seedlings break through the ground. For this treatment enough commercial inoculant for a bushel of seed is mixed with 50 to 60 pounds of moistened cottonseed meal, sand or stable-lot soil. This is broadcast at about 20 pounds or more per acre over the field in rainy or cloudy weather so that sunshine will not kill the bacteria. This second treatment supplies living bacteria to the seedlings just when many young plants need it most, and it pulls them through to provide a good stand.

CLOVER SEEDING RATES ARE VARIABLE

Seeding rates depend upon cost, variety, urgency for quick development, availability of seed, thoroughness of land preparation or certainty of adaptation. A thin stand of a well adapted variety would be expected to reproduce itself to a full stand within a few years by volunteering in favorable conditions. Even so, after thorough and perhaps expensive preparation scant seeding may prove to be poor economy.

Clovers may be seeded on newly prepared seedbeds or on established grass sods. New seedbeds must be prepared months in advance to allow time for the soil to become firm.

Conservative rates per acre for over-seeding well prepared pasture sod land under favorable conditions for each of the following:

Hop clover	1 lb.	Bur-clover (in bur)	12 (1 bu.)
White clover	2	Biennial sweetclover	6
Persian clover	2	Hubam sweetclover	6
Sourclover (M. indica)	4	Common lespedeza	6
Black medic	4	Tenn. 76 lespedeza	6
Alfalfa	4	Korean lespedeza	8
Bur-clover (hulled)	5 lb.	Kobe lespedeza	8

For mixtures, the rates would be reduced proportionately. Lower seeding rates than those above may produce good stands under most favorable conditions. Considerably higher rates generally are used in seeding clover meadows or for pure stands on prepared ground. Land preparation, inoculation, fertilization, and moisture affect results much more than seeding rates.

Sown seed must be covered immediately to protect the inoculant bacteria from exposure to drying, killing sunlight. Firm soil is necessary. Clovers seldom survive in a deep, loose seedbed which dries out too quickly. A moist, firm, freshly-harrowed or cultipacked soil is most favorable to clover.

Irrigated pastures should have enough moisture in the soil at the time of planting to get a stand rooted. Additional irrigations may be necessary to prevent drying and crusting, since continuous moisture during early growth is necessary.

An irrigated pasture requires about the same seasonal total of irrigation water as an alfalfa field but requires smaller, more frequent applications. Water moves slower over land covered with a well-managed pasture sod than over land in alfalfa or small grain, but it penetrates the sod-covered soil faster. For the sod area, therefore, relatively large heads of water may be necessary to obtain quick coverage and efficient distribution of moisture to the root zone.

Sow the seed with any kind of seeder or a grain drill with grass seed attachment, or by hand. Sow either broadcast or in rows. Seed and fertilizer can be applied at the same time if seed tubes are back of fertilizer tubes. Various makes of both picker wheel and cell drop type of cotton seed hoppers have proved satisfactory for planting trashy bur-clover burs. Planter box devices for regulating the rate of seeding hulled clover seed are coming into use.

SPOT-SEEDING

Clover seed mixed with manure requires the lowest rate of seeding and is most popular in small pastures (especially when seed is scarce and expensive). Also this method, called spot-seeding, is the best assurance of getting a stand of seeded clover at lowest seed cost, but with most work. Clover seed is mixed with well rotted, pulverized manure or stable-lot screened sweepings. A large double side-boarded wagon load or 2½ cubic yards of this humus-soil weighs about 1¼ tons with 50 percent moisture. When dry, it weighs only half as much. Clover needs phosphoric acid and must have plenty. Manure contains less than half the amount required. Therefore, with 1¼ tons of old manure sweepings, mix in 50 pounds of 20 percent superphosphate and 10 pounds of muriate of potash, before adding inoculated clover seed.

To prepare the mix for an acre, spread a layer of one-tenth

Experimental pastures at the Lufkin station
(Courtesy Tex. Agr. Exp. Station)

the manure in a wagon, sprinkle on about one-tenth of the fertilizer and stir thoroughly. Sprinkle in one-tenth of the seed and stir again. Repeat until the wagon is loaded.

The two and one-half cubic yards is about right for one acre applied either in one-half-pound handfuls per square yard or in two-pound half-shovelfuls per four square yards. Pitching this pulverized mixture out may separate seed and manure, especially if it is dry. Lay it down and spread it a half-inch thick. Or better, hoe it into moist soil away from birds and to preserve inoculation out of sunlight. Harrowing or rolling, especially cultipacking, is extra insurance of a good stand. Sown in a good fall season, the clovers come up with the first moisture, but lespedezas are not expected to come up until spring.

Clover seeding rates with manure-mixture per acre, or per 1¼-ton load, are about one-half pound of the true clovers, white, persian, and hop, separately or together. Mixtures are cheaper and generally those from reliable firms are good enough. Higher rates are needed for larger seeded clovers such as black medic and sourclover. For these use three-fourths pound; white sweetclover, one pound; alfalfa and hulled bur-clover, one and one-fourth pounds (in the bur, four pounds); lespedezas, one pound.

HARVESTING CLOVER SEED

Most all clovers depend upon bees for pollinizing blossoms to assure seed set. Persian clover seems to be one of the exceptions. Pollination by other insects is of small importance. Formerly, bumble bees were deemed necessary for red clover, but in Ohio research 15 percent of red clover was pollinated by bumble bees; 82 percent was by honey-bees, and but 3 percent by other insects. Lack of sufficient pollination lowers seed yields. A minimum of one hive of honey bees per acre of clover within one and one-half miles should assure good seed yields.

Clovers mostly self-fertilized are: Bur-clover, black medic, sourclover, hop clovers, persian clover, sub clover, and lespedezas. Seed bearing in self-pollinated clovers is less affected by weather conditions and the absence or scarcity of beneficial insects.

Clovers mostly cross-fertilized are: Alfalfa, madrid sweetclover, alsike clover, red clover, and white clover. After the flowers are open, pollination generally is done by visiting insects seeking nectar and pollen. This must occur within three to five days; otherwise seed will not likely be formed.

A very satisfactory method of harvesting white, hop and persian clovers is cutting with the mower when the seed is ma-

ture but before shattering starts, using a buncher attached to the cutter-bar. Rake at once with side delivery rake if buncher is not used. A dump-rake is not as good but may be used if dumps are light. Cure clover in the windrow, turning if it gets wet. In two to three days it should be ready to hull.

The best way of hulling is with a combine with pick-up attachment. Hold down speed of machine and wind to prevent blowing away the seed. A clover huller or threshing machine with the huller attachments can be used. The clover, in this case, is hauled from windrows to the thresher with as little loss of seed as possible. The thrasher should be set to prevent too much seed being blown over. This will usually leave trash in the seed. Trashy seed may be recleaned with a fanning mill. White clover can be handled from the swath with a pick-up combine but there is some loss of seed.

The seed can be saved in the chaff by cutting and curing as above and then throwing off roughly from the wagon on the floor or a clean place on the ground, beating with the forks and shaking as the straw is thrown off and the chaff mainly left behind. This seed in the chaff can be handled in large bags and seeded by hand.

The simplest method of saving seed is in the hay. The crop is handled as above for thrashing, using either kind of rake or buncher and then at once, while tough, it is hauled and scattered as thinly as possible over land where a stand is desired. It can be scattered as sparsely as is necessary but should be strung out over the field so that it can spread in growth and soon make a stand. Also the hay can be cured and stored in the barn for spreading in the early fall.

Bur-clover seed is swept from the ground after burs and vines are dry. Vines may be gathered with a horse rake or hand rake with or without mowing, and swept up with stiff brooms when pods are thoroughly dry. These seeds can be used for immediate planting. Light disking in the fall assures

White clover and dallisgrass pasture on the Texas Gulf Coast

covering and helps early germination and growth. Green burs in piles may heat. A suction-type harvester is commercially available.

NUMBER OF CLOVER SEED PER POUND

Hop clover	1,000,000	Little bur-clover	400,000
White clover	800,000	Bur-clover in bur	67,000
Alsike clover	700,000	Alfalfa	200,000
Persian clover	675,000	Common lespedeza	310,000
Black medic	300,000	Tenn. 76 lespedeza	310,000
Sweetclover	260,000	Kobe lespedeza	190,000
California bur-clover	140,000	Korean lespedeza	225,000
Spotted bur-clover (hulled)	210,000		

TROUBLE LURKS IN LUSH PASTURES

With fertile soil and abundant moisture, the better a pasture appears to be, the more difficult its management may be. Greedy gorging of fresh tender clover by cattle and sheep may result in the animals bloating. Clovers wet from rain or dew seem most liable to cause bloating. Probably it is the tenderness that incites greed. Evidently it is not the wetness of the clover but too much of it that causes the trouble. Dry cows seldom bloat. It is usually cows in milk or growing animals with large appetites that gorge themselves and bloat.

Close grazing and feeding hay or plenty of dry pasture grass should remedy many of the causes of ruminants bloating. Fibrous roughage is needed to stimulate normal paunch action. Muscular contraction of the paunch forms the cud and belches out the gas. A good fill of coarse, dry hay, grass pasturage or silage is the most effective preventive to bloating on pastures which are too succulent. Sudan grass or other sorghum hay is ideal.

Lush growth of pasture clovers must not be allowed too much ahead of grazing. Dividing pastures into smaller units and stocking them heavily, one at a time in rotation, to obtain close and even grazing, is good management. Over-growth left in other pastures is available as the hay also needed in lush growing seasons.

In addition, as a rule, there is but little bloating of animals pastured on grass. Bloat may be lessened by mixing grasses with alfalfa on western irrigated pastures.

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